A Tale of Two Regimes: Classifying and Revisiting the Monetary Policy Regimes

Wong, Kin Ming and Chong, Terence Tai Leung

The Chinese University of Hong Kong

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Kin-Ming Wong and Terence Tai-Leung Chong*

Department of Economics

The Chinese University of Hong Kong

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Abstract: The existing literature on the performance of monetary policy regimes is separate and isolated, with unidentified monetary policy framework for floating rate regime in the exchange rate regime literature and non-inflation targeting regime in the inflation targeting literature. This paper proposes a comprehensive *de facto* classification of monetary policy regimes based on the behavior of economic variables. The result reveals a non-negligible number of "hidden inflation targeters", which use inflation targeting monetary policy in the absence of formally announced inflation targets. Based on the classification result, we also document monetary history and stylized facts that are highly consistent to our conventional understandings.

JEL Classifications: E42, E52, E58

Keywords: Monetary Policy Regimes; Inflation Targeting; Exchange-rate Targeting

* Corresponding author: Terence Tai-Leung Chong, Department of Economics, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong. Email: chong2064@cuhk.edu.hk.

"Floating is not a well-defined monetary policy. If the central bank doesn't fix the exchange rate, it has to do something else—but what? The academic profession should move away from considering 'Exchange Rate Regimes' and instead classify countries by 'Monetary Policy Frameworks'."

Rose (2011)

1. Introduction

Monetary policy is arguably one of the most important tools for government to influence the economy. Economists and policy-makers have long sought the ideal framework for monetary policy. Three nominal variables- namely exchange rate, monetary aggregate and inflation, have been suggested to be the most appealing anchors and are widely studied[1]. Contrary to the long-established record on exchange rate arrangements, however, the International Monetary Fund (IMF) compiles a comprehensive classification on monetary policy regimes for its members in recent years only[2].

Several studies in the inflation targeting literature, including Ball and Sheriden (2005), Bernanke and Mishkin (1997), Carare and Stone (2006), Cottarelli and Giannini (1997), Fatas et al. (2007), Mishkin and Schmidt-Hebbel (2002), have extended the identification of inflation targeters to a longer period and a larger group of countries. Most of these works, including the classification of the IMF have used

[1] See, for example, Friedman (1968), Bernanke et al. (1999) and Mishkin (1999). The well-known Taylor rule and variants are also regarded as a monetary policy rule for inflation targeting as suggested in Mishkin (1999) and Svensson (1999).

[2] A "De Facto Classification of Exchange Rate Regimes and Monetary Policy Frameworks" has been included in IMF's Exchange Arrangements and Exchange Restrictions after 2001.

the announcement of inflation targets as their main identification strategy[3]. The classified regimes in these studies are therefore *de jure* in nature. The announcement of inflation targets is considered as an important element of the inflation targeting policy, especially when inflation targeting is viewed as a framework in a broad sense[4]. However, the large literature on exchange rate regimes has shown that policies of many countries in practice may not be consistent with their publicly disclosed regimes. For example, Calvo and Reinhart (2002) and Levy-Yeyati and Sturzenegger (2005) have identified a number of countries as having "fear of floating" and "hidden pegs". The works of Stone and Bhundia (2004) and Carare and Stone (2006) also find that some countries, named as implicit price stability anchors, manage their monetary policy to maintain low and stable inflation without any announced targets on inflation. Another group of countries, by contrast, have low credibility to prove the announced inflation targets as their foremost policy objective. Similarly, Mishkin (p.5, 2001) also argues that several monetary aggregate targeting countries failed to control inflation because "monetary targeting was not pursued seriously" by these countries.

The literature on exchange rate regimes is probably more extensive and has a longer history. The possible deviation of a country's intervention in foreign exchange markets in practice from its declared, or *de jure* exchange rate regime is considered in several *de facto* classifications including Calvo and Reinhart (2002) and Levy-Yeyati and Sturzenegger (2005). Similar to the inflation targeting literature, however, an alternative monetary policy framework is not well identified in the exchange rate regime literature. The unidentified monetary policy framework for floating exchange rate regimes and non-inflation targeting countries in the two areas of study causes the

[3] Stone and Bhundia (2004) and the related work of Carare and Stone (2006) are two exceptions and are discussed later.
[4] See, for example, Bernanke et al. (2001) and Mishkin (2001).

separation and incompleteness of the analyses in the existing literature. This weakness begins to receive increasing attention in the recent literature, including Rose (2011) and the comments from Mark Gertler in Ball and Sheridan (2005)[5].

This paper proposes a comprehensive *de facto* classification of monetary policy regimes. Country-year observations are put into two clearly defined monetary policy regimes, namely exchange rate targeting and inflation targeting[6] according to the observed volatility of three classification variables: interest rate, exchange rate and inflation. As suggested in a simple New Keynesian model, monetary policy regime with a specific target is associated with changes in interest rates aimed at reducing the volatility of the target variable. These criteria are used to group country-year observations in alternative *de facto* monetary policy regimes based on their similarity in the behavior of classification variables with K-means cluster analysis.

The classification identifies 1,489 and 2,952 country-year observations in the inflation targeting regime and exchange rate targeting regime respectively. Based on the classification result, this paper documents the monetary history and stylized facts of the two monetary policy regimes. The result reveals that inflation targeting policy has a much longer history before central banks began to announce official inflation targets in the 1990s. The number of these "hidden inflation targeters", inflation targeting countries without announcing targets, is found to be non-negligible. Stylized facts of the two regimes revisited in this study are largely consistent with the findings in the literature. This suggests that convention understanding of the two regimes

[5] Mark Gertler has made the following comment in Ball and Sheridan (2005). "In principle, one can only assess the effects of inflation targeting by having a clear alternative monetary policy regime as a benchmark. That is, to draw conclusions about inflation targeting, one must ask what it is being compared to."

[6] The rationale for the regimes to be included in this classification is in section 2.

documented separately in the exchange rate and inflation targeting literature may remain valid in a direct comparison of exchange rate targeting and inflation targeting regimes.

The rest of this paper is organized as follows. Section 2 presents the methodology used in the classification with details of the monetary policy regimes to be identified, classification variables and clusters suggested by a simple New Keynesian model and the classification procedure. Discussions on the classification result are given in section 3 with comparisons between existing classifications in the literature and an interpretation of modern monetary history based on the result. Section 4 documents the stylized facts of the two classified monetary policy regimes. The choice of alternative regimes is also explored with a Probit model using the panel data. A brief conclusion is offered in section 5.

2. Methodology

This study covers the post-Bretton Woods period from 1974 to 2009 and the 228 countries reported to the IMF during this period. This results in 7,980 country-year observations at the most. Upon excluding 3,902 observations with unavailable data for at least one of the classification variables[7] and 161 outliers in the data, the remaining 3,917 observations are classified using the cluster analysis.

Cluster analysis is one of the popular methods used to identify groups of homogeneous observations in the data. Homogeneity between data is quantified with

[7] In some cases, data of a country may not be available since the country does not exist in the entire sample period. Out of the 228 countries reported in the list of IMF, 186 countries have been classified at least for one period.

various similarity or distance measures, such as Euclidean distance in the pre-defined classification variables. The clustering technique has been used in a remarkable number of disciplines including archaeology, biology, medicine, psychology and marketing. In economics, Crone (2005) uses the technique to explore economic regions with similar business cycles in the United States. This study is more closely related to Levy-Yeyati and Sturzenegger (2005), who applied the cluster analysis to classify observations in different exchange rate regimes.

Hierarchical and K-means clustering are two alternative approaches to perform the cluster analysis. Hierarchical cluster analysis starts from identifying the two closest subjects and grouping them into one cluster. This procedure continues to identify the closest subject to the previous formed cluster successively until all subjects are grouped into a single cluster. Hierarchical cluster analysis is especially useful when the number of clusters is uncertain. This approach, however, assigns subjects to a cluster on a single pass of analysis, which prevents the reevaluation of previous groupings and reassignment of subjects.

This study follows Levy-Yeyati and Sturzenegger (2005), using the K-means cluster analysis, which is an alternative approach that involves repeated attempts to reach an optimal assignment for the classification. The K-means clustering partitions data into pre-specified k groups through iteration and typically involves two steps. In the first step, k observations are selected as the initial centers of clusters and each remaining observation is assigned to a closest cluster center. Cluster centers are then updated with all assigned observations in the cluster and each observation is re-assigned to the new closest cluster center in the second step. This step continues

iteratively until there is no more reassignment in the current attempt. The number of clusters and classification variables required in the K-means cluster analysis are further discussed later.

2.1. The Monetary Policy Regimes

Exchange rate, inflation and monetary aggregate are the three nominal variables suggested to be the most appealing anchors for monetary policy and are frequently mentioned in the literature on monetary policy history. Among these three regimes, exchange rate targeting (or fixed exchange rate) and inflation targeting are widely studied. Monetary targeting, on the other hand, has received much less attention. One potential explanation of this lack of interest relates to the validity of this regime.

Monetary targeting is said to be a strategy mostly used in the 1970s. However, many studies including Mishkin (2001) have argued that this strategy was not seriously pursued. Bernanke and Mishkin (1997) and Bernanke et al. (1999) also suggest that many monetary targeting countries, including the two classical examples of Germany and Switzerland, are better viewed as "hybrid" inflation and monetary targeters. They also comment that "distinction between inflation and money targeting is overstated". Bernanke and Mihov (1997) and Clarida et al. (1998) support these arguments with empirical evidence from the policy reaction function. Their estimations of policy reaction functions show that Bundesbank, the central bank of Germany, responded more to inflation than to the announced target: the growth of monetary aggregate.

In fact, monetary targeters identified in previous classifications are usually rare[8]. In view of the sensitivity of K-means cluster analysis to groups with extreme small number of observations[9], the classification regimes in this study focus on the two major monetary policy strategies: exchange rate targeting and inflation targeting[10].

2.2. Classification Variables and Clusters

The definition of "targeting" in monetary policy is not without argument. In some literature, a target variable is understood as a variable that the monetary policy rule responds to. This literature therefore identifies a *de facto* regime by estimating the significant variables in the central bank's monetary policy reaction function. On the other hand, some literature defines a target (as well as an intermediate target) variable as the variable in some forms of loss function. To minimize the loss function, Rudebusch and Svensson (1999) and Svensson (1999) show that monetary policy may respond to a set of variables other than the target. The first definition of targeting regime using a target variable in monetary policy reaction function, therefore, could be misleading. Neither of these two terminologies could be said to be fully satisfactory[11].

In this classification, a regime targeting a specific economic variable is

[8] For example, Stone and Bhundia (2004) have only classified 35 country-year observations as money anchors in their 1,353 data.
[9] For example, see Scott and Symons (1971).
[10] Empirically, a cluster for monetary targeters is not identified in various settings of variables and number of clusters.
[11] Discussions on the two alternative definitions could be found in Rudebusch and Svensson (1999), Svensson (1999) and the Appendix A in the working paper version of McCallum and Nelson (1999).

defined as in Rudebusch and Svensson (1999) and Svensson (1999). The behavior of various economic variables in alternative monetary policy regimes could be evaluated under a basic New Keynesian model following Galí (2008)[12], in which the central bank is assumed to follow a simple interest rate rule of the form

$$r_t = rr + \phi v_t \tag{1}$$

to minimize the following loss function

$$\frac{1}{2} E_t \sum_{i=1}^{\infty} \beta^i a_{t+i}^2 . \tag{2}$$

where r_t is the nominal interest rate, rr is the constant natural rate of interest, ϕ is the coefficient to the zero-mean i.i.d. cost-push shock, v_t, β is the discount factor and a_t is the target variable of the monetary policy. Under the assumption of nominal price rigidities and complete international financial markets[13], the baseline model can be represented by the following (log-linear) equations for output gap, x_t and domestic inflation $\pi_{H,t}$:

$$x_t = E_t x_{t+1} - \sigma^{-1}\left(r_t - E_t \pi_{H,t+1} - rr\right) \tag{3}$$

$$\pi_{H,t} = \beta E_t \pi_{H,t+1} + \kappa x_t + v_t \tag{4}$$

[12] Clarida et al. (1999) provide a very comprehensive review of the dynamic New Keynesian model. Clarida et al. (2001) and Galí and Monacelli (2005), on the other hand, present variant approaches for open economies.

[13] For a small open economy model with uncertainty in the international financial markets, see Leitemo and Söderström (2008).

where σ and κ represents the response coefficient of the output gap to the real interest rate and the response coefficient of the domestic inflation to the output gap respectively. The optimal coefficient in the interest rate rule and the volatility of various economic variables under a specific target could be obtained by using the method of undetermined coefficients and dynamic optimization. In particular, the volatilities of three variables (interest rate as the instrument variable and exchange rate and inflation as the target variables) in alternative policy regimes are studied and the results are described in Table 1.

The first two rows show that an economic variable usually has lower volatility when it is targeted. It is also possible for certain economic structures to lead to comparably low volatility in the non-targeted variable as shown in the third row[14]. In all these cases, monetary policy intervention required in the presence of shock leads to comparatively high volatility in the interest rate. Finally, the last row suggests that low volatility of variables may also be a result of a low magnitude of shock, characterized by limited intervention in the interest rate. These four outcomes form the fundamental clusters in the classification procedure.

[14] See Galí and Monacelli (2005) for the role of openness on the monetary policy rule and its outcome in a New Keynesian Model.

Table 1. Relative volatility of economic variables under various situations

Magnitude of Shock	Openness	Targeting	Interest rate Volatility	Exchange rate Volatility	Inflation Volatility
High	Low	Inflation	High	High	Low
High	Low	Exchange Rate	High	Low	High
High	High	Either	High	Low	Low
Low	Either	Either	Low	Low	Low

Based on the results in Table 1, volatility of three economic variables, namely interest rate, exchange rate and inflation are used as the classification variables. The annual volatility of exchange rate and interest rate is measured as the standard deviation of the absolute monthly percentage changes in the corresponding variables in a calendar year[15]. Following Levy-Yeyati and Sturzenegger (2005), this study has included several major currencies as the reference currencies to compute the exchange rate volatility, and the one exhibiting the lowest volatility is used[16]. Since inflation targets are rarely set to be achieved in a short period, such as a year[17], the standard deviation of monthly inflation rate over a two-year period is used as a measure of long-term inflation volatility. Definitions and sources of all data used in this study are

[15] Using this measure means crawling peg, a policy that allows the exchange rate to change gradually and as planned, is considered as a kind of exchange rate targeting policy.

[16] The reference currencies included in the computation are the US dollar, the British pound, the Deutsche Mark, the French franc, the Japanese Yen, the SDR, the ECU and the Euro. Other currencies are used for specific countries with reference to Appendix B of Levy-Yeyati and Sturzenegger (2005) and the list of currency union in Rose (2000).

[17] For example, Bernanke and Mishkin (1997) suggest, "(inflation targets) are typically established for multiple horizons ranging from one to four years."

provided in Appendix A[18].

2.2.1. Classification Procedure

This study closely follows the classification procedure in Levy-Yeyati and Sturzenegger (2005). Technically, this study differs from Levy-Yeyati and Sturzenegger (2005) in two areas to improve performance of the cluster analysis.

It is well known in the cluster analysis literature that K-means algorithms do not necessarily converge to a global optimum. The K-means algorithms may terminate at different local optimums with different specified initial centers. This study uses different sets of random observations instead of one specified set of observations in Levy-Yeyati and Sturzenegger (2005) as the initial center to address the local optimum problem[19]. The set of initial centers that results in the highest similarity measure is adopted. Another problem to be addressed in the K-means cluster analysis relates to the standardization of variables. No matter which distance measure is used, variables are required to be standardized into the same unit of measure. Otherwise, variables with larger values will have a larger impact on the classification. The z-normalization is a traditionally-used method for standardization and is used in Levy-Yeyati and Sturzenegger (2005), but several studies show that standardization by range results in consistently superior recovery of the underlying

[18] The monthly consumer price index and money market rate are the primary sources of reference to compute the monthly inflation rate and interest rate. Supplementary sources of references are used when the primary source is not available. For example, quarterly consumer price index and retail price index are used for the computation of inflation with appropriate adjustments, while lending rate and monetary policy related interest rate are used as the supplementary measure for interest rate. It is important to stress that the classification result in this study is not sensitive to the use of supplementary sources of references and various definition of classification variables, including the use of short-term or long-term inflation.

[19] In particular, the algorithm of this study uses 1,000 randomly selected sets of observations as initial centers and the maximum number of iteration is set to 10,000.

cluster structure[20]. In view of this, classification variables are standardized in this study by their ranges.

The classification procedure in this study is divided into several steps. K-means cluster analysis is sensitive to outliers, as they are usually selected as cluster centers, and thus results in outlying clusters with a small number of observations. Following Levy-Yeyati and Sturzenegger (2005), two percent of the upper tail of observations of each classification variables is removed from the data. These outliers are classified into alternative monetary policy regimes in the later step. The remaining observations are range standardized and classified into the four clusters described in Table 1. As described in Table 1, the classification results in two inconclusive categories: the first shows evidence of monetary policy intervention, but policy target is unclear; the second has low volatility in both instrument and target variables because of less intensity of underlying shock.

Observations in these two inconclusive clusters are further analyzed with re-standardized variables. For observations in the first inconclusive cluster, they are further classified into alternative monetary policy regimes in a second stage. In the second stage, only the two target variables are used for classification as the data to be classified have already shown clear evidence of policy intervention in the previous stage. For the second inconclusive cluster, another round of classification with the four described clusters using all three classification variables is performed to account for different levels of underlying macroeconomic volatility, as suggested in Levy-Yeyati and Sturzenegger (2005). Finally, three rounds of the two-stage classification

[20] See, for example, Milligan and Cooper (1988) for a simulation study based on hierarchical cluster analysis and Steinley (2004) for a more related study using K-means cluster analysis.

have been performed with 1,275 observations left in the inconclusive group.

Descriptive statistics of regimes classified in various rounds and stages are provided in Table 2. The result suggests that the magnitude of policy intervention in two monetary policy regimes is similar, as reflected in their interest rate volatility. A monetary policy regime generally has lower volatility in the target variable and higher volatility in the non-target variable. It is important to stress that the classification is based on the relative volatility of the classification variables. Therefore, an observation in exchange rate targeting regime can have lower volatility of inflation than another observation in inflation targeting regimes. This is reflected in the overlap of minimum and maximum values of the two target variables between alternative regimes. As expected, observations classified in the later round of classification have lower volatility in all instrument and economic variables since they are subject to less intensity of shock. The statistics in Table 2 also show that statistics of the same monetary policy regime in the first and second stage of each round's classification are highly comparable. This suggests that observations classified in the second stage belong to the two specified monetary policy regimes: exchange rate targeting and inflation targeting instead of another undefined regime.

Table 2. Descriptive statistics of various clusters

	Interest rate volatility			Exchange rate volatility			Inflation volatility		
in (%)	Min	Cen.	Max	Min	Cen.	Max	Min	Cen.	Max
First round									
Inflation targeting	0.00	1.21	7.04	2.42	4.78	10.92	0.54	9.25	38.42
Ex. rate targeting	0.00	0.81	7.38	0.00	0.77	3.83	10.52	19.64	53.46
Second stage									
Inf. targeting	3.08	5.50	8.93	2.01	3.13	6.17	2.30	9.21	19.45
Ex. rate targeting	3.21	6.41	10.88	0.04	0.80	2.24	13.69	21.71	43.40
Second round									
Inflation targeting	0.00	0.35	1.68	0.74	1.41	3.02	0.15	2.16	8.07
Ex. rate targeting	0.00	0.21	1.58	0.00	0.24	2.15	3.79	6.16	11.24
Second stage									
Inf. targeting	0.97	1.66	2.50	0.73	1.25	2.55	0.35	2.65	5.73
Ex. rate targeting	0.94	1.67	2.54	0.04	0.69	2.03	4.07	6.02	9.72
Third round									
Inflation targeting	0.00	0.16	0.58	0.30	0.57	0.88	0.15	1.23	3.66
Ex. rate targeting	0.00	0.11	0.67	0.00	0.06	0.55	1.90	2.83	3.85
Second stage									
Inf. targeting	0.29	0.58	0.92	0.20	0.39	0.66	0.21	0.90	1.63
Ex. rate targeting	0.34	0.61	0.97	0.00	0.08	0.25	0.31	1.32	2.84

In the final step, observations that remain unclassified are further analyzed. In addition to the 1,275 inconclusive observations in the cluster analysis, this also includes the 161 outliers and 3,902 observations with unavailable classification variables that are excluded from the classification procedure. The classification of the 161 outliers is straightforward and most of them can be assigned to one of the cluster centers identified in the cluster analysis with minimum distance. The ad hoc classification of the 1,275 inconclusive observations and 3,902 observations with

unavailable variables is based on the methodology of Levy-Yeyati and Sturzenegger (2005). An observation is assigned to the exchange rate targeting regime if it (i) has zero volatility in the exchange rate, or (ii) is identified as a fixed exchange rate regime by the IMF and has less than 0.1% volatility in the exchange rate. Similar to Levy-Yeyati and Sturzenegger (2005), the 0.1% volatility in the exchange rate places a comfortable buffer from the minimum exchange rate volatility of the inflation targeting regime (which is 0.2%). In this sense, countries without an independent legal tender including members of Euro zone are also classified as exchange rate targeting. The classification procedure is depicted in Appendix B.

3. The Classification Result

3.1. Comparisons with Other Classifications

The classification has identified 2,957 country-year observations in the exchange rate targeting regime and 1,489 observations in the inflation targeting regime. Table 3 presents comparisons between the current analysis and several existing classifications to offer some understanding about the result. The upper panel compares the result to two *de facto* classifications. Not surprisingly, most of the inflation targeting regimes identified in this study come from the float and intermediate regimes in LYS (2005)[21]. A few exceptions are New Zealand (1986, 1989, 1992, 1993–2004), Finland (1980, 1982–89, 1991–1996), Norway (1983–84, 1995–2003) and Bostwana (1984–86, 1988–94, 1997–2004), which are fixed exchange rate regimes in LYS (2005), but inflation targeters in the current study. New

[21] The latest version of LYS classification has been extended to cover the period up to 2004 and is available at the website of Levy-Yeyati.

Zealand and Finland are widely agreed inflation targeting countries since the 1990s in the literature. Norway, on the other hand, is not traditionally recognized as an inflation targeter. Stone and Bhundia (2004), however, find that the country has been using *de facto* inflation targeting policy (named as implicit price anchor) since late 1990s, and continues to do so after the central bank announced an inflation target in 2001.

Table 3. Comparison between classifications

(a) Comparisons with de facto classifications

Regime	All data	LYS (1974–2004)		SB (1990–2005)	
	(1974–2009)	Fix	Non-fix	Fix	IT
Inflation targeting	1,489	238	717	155	218
Exchange rate targeting	2,952	1,959	237	367	0

(b) Comparisons with de jure classifications

		IMF (2001–2009)		Fatas et al. (1974–2000)	
		Fix	IT	Others	De Jure IT
Inflation targeting	1,489	134	202	397	69
Exchange rate targeting	2,952	719	6	260	0

Periods covered in other classifications are various. The total number of observations in other studies does not necessarily equal the total number of observations in this study.

The case of New Zealand, Finland and Norway highlights the importance of having a clearly defined alternative policy regime in the classification. Consider their heavy intervention in foreign exchange markets and relative stable currencies: these countries could be easily grouped with other fixed exchange rate regimes. The inclusion of inflation targeting as the alternative monetary policy regime in this study reveals that their intervention in exchange rates could be a way to stabilize the

inflation or, at least, inflation has a higher priority than exchange rate as their monetary policy targets.

Botswana is probably a more interesting case for discussion. The country's currency, Pula, was first pegged to the US dollar in 1976 and then to a currency basket in 1980. Therefore, the country is identified to have a fixed exchange rate in most classifications. The peg of Pula, however, is far from stable and has experienced frequent and substantial adjustments. In many cases, the revaluation or devaluation was introduced as an anti-inflation measure[22]. Several studies also support this view by identifying inflation as a key variable in the monetary reaction function of the Bank of Botswana[23].

Of those regimes successfully identified in this study, all of the *de facto* inflation targeters in Stone and Bhundia (2004) are grouped into the inflation targeting regime in this study as well. A non-negligible proportion of exchange rate anchors in Stone and Bhundia (2004), on the other hand, is identified as inflation targeters in this study[24]. A possible explanation of this divergence is that Stone and Bhundia (2004) have excluded the exchange rate anchors from their *de facto* classification procedure. Instead, they adopted the identification for exchange rate anchors from the IMF classification, which is considered a mixed *de jure-de facto* approach based on subjective judgment.

[22] For example, Pula has been adjusted seven times in the 12-year period from 1980 to 1991. Each adjustment ranged from 5% to 15%. Masalila and Motshidisi (2003), a study of the Bank for International Settlements by two researchers from the Bank of Botswana provides the background of the exchange rate policy of Botswana in more detail.
[23] See, for example, Bleaney and Lisenda (2001) and Setlhare (2004).
[24] The *de facto* inflation targeters in Stone and Bhundia (2004) include the full-fledged integration targeting regime and implicit price stability anchor, while exchange rate anchor comes from nonautonomous (monetary policy) regime and exchange rate peg. Of the 232 inflation targeters classified in Stone and Bhundia (2004), 20 of them are classified as inconclusive in this study.

A comparison with the *de jure* or partial *de jure* classification by the IMF and Fatas et al. (2007) in the lower panel reveals another interesting story. There are no "pretended inflation targeters" since all countries announcing inflation targets are also *de facto* inflation targeters. However, there are quite a large number of "hidden inflation targeters", which describe themselves as fixed exchange rate regimes but target inflation in practice. Unsurprisingly, many of these "hidden inflation targeters" are also classified as "implicit price stability anchors" according to their inflation performance in Stone and Bhundia (2004). Central bank communications, especially those on the policy target, are widely agreed to be one of the pillars of the inflation targeting framework. The existence of a large number of "hidden inflation targeters" is therefore an important area for further exploration. Even though an explanation for "hidden inflation targeters" is out of the scope of this study, the study of Morris and Shin (2002) may offer a hint. The main conclusion in Morris and Shin (2002) and subsequent follow-ups in Svensson (2006) and Morris et al. (2006) is that central bank communications could reduce social welfare in some special circumstances, including the case of imprecise information. This explanation is consistent with the fact that a larger share of the "hidden inflation targeters" comes from the pre-1990s period when central bank information is likely less precise than the later period.

3.2. An Interpretation of the Monetary History

The number and percentage of classified regimes in various periods from 1974 to 2009 are presented in Table 4.

Table 4. Classification of monetary policy regime by year

	All Countries			Advanced		Emerging	
	All IT	***Hidden IT***	**ET**	**IT**	**ET**	**IT**	**ET**
1974-79	71	*61*	489	55	43	8	50
	(13%)	*(86%)*	(87%)	(56%)	(44%)	(14%)	(86%)
1980-89	334	*182*	791	145	62	56	45
	(30%)	*(54%)*	(70%)	(70%)	(30%)	(55%)	(45%)
1990-99	472	*147*	743	175	56	78	62
	(39%)	*(31%)*	(61%)	(76%)	(24%)	(56%)	(44%)
2000-09	612	*N.A.*	929	156	158	145	45
	(40%)	*(-)*	(60%)	(50%)	(50%)	(76%)	(24%)

Figures in parentheses indicate the percentage of classified observations in the corresponding category for total, advanced countries and emerging countries. Figures in the parentheses are the percentage of total inflation targeting regimes for hidden inflation targeters.

Generally speaking, the figures are consistent with the impression that inflation targeting has been emerging as a more typical strategy in the past few decades. Exchange rate targeting, on the other hand, is still common, but its share has been diminishing since the collapse of the Bretton Woods system. Most existing literature starts its discussion on inflation targeting history since the 1980s, when countries began to have a formal inflation targeting framework in place. The statistics suggest that *de facto* inflation targeting actually has a longer history with most of them acting as hidden inflation targeters.

Inflation targeting has displaced exchange rate targeting as the major monetary policy regime in the advanced economies, immediately after the fall of the Bretton Woods system, and became more popular in the 1980s and 1990s. The trend only

reversed in the last decade when some European countries decided to give up their monetary policy autonomy to adopt the new single currency, the Euro. Emerging countries, on the other hand, seem to be more hesitant in shifting their targets from exchange rate to inflation in the early period but have finally caught up to the trend in the later period.

The classification supports the argument of Bernanke and Mishkin (1997) and Bernanke et al. (1999) that the two self-described monetary targeters, Germany and Switzerland, share many similarities with other countries using inflation targeting. For most yearly data, these two countries are classified as *de facto* inflation targeters. The Euro area is not considered a single entity in the classification procedure, but the monetary strategy of the European Central Bank should be an interesting case for discussion. Using out-of-sample classification, the European Central Bank has been adopting inflation targeting since its inception[25].

4. The Two Monetary Policy Regimes

4.1. Stylized Facts

Stylized facts of the two monetary policy regimes are described in Table 5 based on the simple averages of two groups. The result could be interpreted together with similar studies in Levy-Yeyati and Sturzenegger (2003), Husain et al. (2005) and the survey by Tavlas et al. (2008) for the exchange rate regimes; Rose (2007), Ball

[25] Complete yearly data for the Euro area is available from 2000 to 2009. The Euro area has the nearest distance to the inflation targeting clusters in the second or the third round classification.

and Sheridan (2005) and the survey by Walsh (2009) for the inflation targeting regimes. Unlike these studies, the two alternative monetary policy regimes are well-identified for comparison in this study.

Table 5. Economic Performance and Characteristics of the Two Regimes

	All Countries		**Advanced**		**Emerging**	
	IT	**ET**	**IT**	**ET**	**IT**	**ET**
			(a) Economic Performance of Two Regimes			
Duration in years	3.47	9.58 (***)	5.87	5.32 ( )	3.04	2.34 ( )
Crisis tally	0.92	0.97 ( )	0.58	0.67 ( )	1.19	1.63 (***)
Real GDP growth	3.38	3.92 (***)	3.07	2.97 ( )	3.63	3.99 ( )
Inflation	12.87	44.92 (***)	5.51	9.11 ( )	13.99	163.00 (***)
excluding >250	11.96	11.61 ( )	5.51	6.74 ( )	13.99	23.14 (***)
Effective exchange rate volatility:						
Nominal	1.78	1.32 (***)	1.16	0.69 (***)	2.17	1.92 ( )
Real	1.91	1.76 ( )	1.15	0.62 (***)	2.20	2.25 ( )
			(b) Economic Characteristics of Two Regimes			
Real GDP (in bn)	583.25	106.85 (***)	1,412.45	538.96 (***)	296.72	335.33 ( )
Real GDP per capita (in '000)	14.25	8.57 (***)	32.18	34.28 ( )	5.93	5.29 ( )
Trade openness	0.34	0.45 (***)	0.33	0.66 (***)	0.35	0.32 ( )
Trade concentration	0.25	0.28 (***)	0.23	0.23 ( )	0.25	0.25 ( )
Capital openness	0.03	0.06 (***)	0.07	0.44 (***)	0.02	0.02 ( )
Years in Office	5.71	8.26 (***)	3.99	4.44 ( )	4.44	5.91 (**)

**** and ** represent that the two simple means of inflation targeting regime and exchange rate targeting regime are significantly different at the 1% and 5% level, respectively based on the Welch's t statistics.*

The duration of a regime is measured as the mean of the average number of years a country maintains the regime to avoid the overrepresentation of countries with frequent regime changes. As shown in the upper panel of Table 5, the exchange rate targeting regime is significantly more durable than the inflation targeting regime in the full sample. This result is found to be mainly affected by the extreme durable peg of several small and developing countries as well as countries in the currency union[26]. The difference in duration ceases to exist in the sample of advanced and emerging countries, which is more comparable to the results in Husain et al. (2005) and Rose (2007).

The crisis tally of the two regimes is calculated with the financial crisis database from Reinhart and Rogoff (2011). The two regimes show no significant difference in the occurrence of crisis in the sample of all countries and advanced countries. Exchange rate targeting in emerging countries, by contrast, reports a significantly higher crisis statistics. This result is in line with the finding in Husain et al. (2005) and is consistent with the observation of more sudden stops of capital flows for non-inflation targeters in Rose (2007)[27].

As for the economic performance of two monetary policy regimes, the results generally support Husain et al. (2005), that exchange rate targeting regime has a higher unconditional average economic growth, inflation rate and lower exchange rate volatility. The growth rate in real GDP per capita is higher for exchange rate targeting

[26] The duration for countries in currency unions is found to be extremely long, with an average of 24 years. Excluding currency unions from the exchange rate, targeting regime reduces its average duration from 9.58 years to 5.25 years. The difference remains significant at 5% level.
[27] See, for example, Calvo et al. (2006) for the relationship between a sudden stop of capital flow and crisis in emerging economies.

regime, but the difference is not significant in advanced and emerging countries. The result on the inflation rate level is consistent across various subsamples but is found to be affected by a few hyperinflation observations in the exchange rate targeting regime. Once the hyperinflation data is removed, the inflation levels of the two regimes are more comparable and the differences in all countries become insignificant.

4.2. Who Targets Inflation?

The choice of monetary policy regimes is itself endogenous and depends on economic structures. Literature attempts to identify the structural differences between inflation targeters and non-inflation targeters, including Gerlach (1999) and Carare and Stone (2006). Levy-Yeyati et al. (2010), on the other hand, empirically estimated the endogeneity of exchange rate regimes using variables with stronger theoretical support. The lower panel of Table 5 presents the key variables used in Levy-Yeyati et al. (2010) for the two monetary policy regimes. The size of the economy as represented by the real GDP, trade openness and concentration, captures the importance of trade aspects suggested by the optimal currency area. Capital openness, as measured by the total flows of portfolio investments as a share of GDP, is the main proxy in the financial theory, which argues a stable exchange rate is preferable to avoid currency mismatch in financial assets and liabilities. The variable of years in office is the number of years that the incumbent administration has been in office. According to the sustainability hypothesis in the political theory, a weak government (as indicated by fewer years in office) is difficult to sustain a fixed exchange rate. This argument is even stronger when inflation targeting is identified as the alternative

monetary policy regime since inflation, different from the exchange rate, is non-tradable and therefore not subject to speculation.

Table 6. Probit Regression Results for Inflation Targeting Regime

	(1)	(2)	(3)	(4)
Real GDP	0.714***	0.484***	0.665***	-1.018*
	(0.079)	(0.072)	(0.085)	(0.566)
Trade openness	-0.908	-2.431***	-1.136*	-3.128
	(0.577)	(0.578)	(0.583)	(4.768)
Trade concentration	-0.020	0.003	-0.002	-4.640***
	(0.576)	(0.185)	(0.183)	(1.547)
Capital openness	-4.141***	-4.806***	-4.458***	-5.538
	(1.195)	(1.198)	(1.224)	(12.079)
Years in office	-0.268***	-0.282***	-0.235***	-0.078
	(0.078)	(0.075)	(0.080)	(0.662)
Advanced Country		0.864**		1.753
		(0.339)		(3.662)
Emerging Country		-0.075		8.534
		(0.322)		(4.569)
Real GDP per capita			-0.124	
			(0.103)	
Inflation				-0.483***
				(0.131)
N	2,422	2,422	2,422	369
Pseudo R2	0.089	0.092	0.089	0.548

The dependent variable is the dummy for de facto inflation targeting regime in model (1) to (3) and it is the dummy for de jure inflation targeting regime in Model (4). All regressions include an intercept.

*Model (1) to (3) include year dummies and Model (4) includes dummies for decades. All variables except years in office and the dummies for advanced and emerging countries are the lagged values. Standard errors are in parentheses. ***, ** and * represent significance at 1%, 5% and 10%, respectively.*

The choice of inflation targeting regime is estimated by a Probit regression using panel data with random effects, and the results are presented in Table 6. The results generally mirror the findings in Levy-Yeyati et al. (2010). Consistent with the simple averages measured in the lower panel of Table 5, models (1) to (3), under various specifications, suggest that inflation targeters are less open in terms of trade and capital flow, larger in economic size and have weaker governments as reflected in the fewer years in office. The effect of trade concentration, however, is not significant.

The estimation result of model (2) shows that advanced countries are more likely to use inflation targeting as their monetary policy strategy. Interestingly, this result is not caused by the higher income level in advanced countries as reflected in the insignificant effect of the real GDP per capita in model (3). This suggests that institutional factors, for example, independence and credibility of central banks rather than economic characteristics, may better explain the wide adoption of inflation targeting in advanced countries.

Model (4) aims to explore the determinants for an inflation targeter to formally adopt a *de jure* inflation targeting regime (in many cases, with the announcement of an inflation target). The sample is therefore largely reduced to observations that are identified as *de facto* inflation targeters and included in the data set from Fatas *et al*. (2007). The result shows that inflation targeters of smaller size and with lower trade concentration are more likely to explicitly establish an inflation target. The

significance of the lagged inflation rate level in the estimation also supports several comments made in the literature that a central bank usually announces a formal inflation target after it has successfully controlled inflation to a lower level and establishes its credibility in fighting inflation.

5. Conclusion

Existing literature on the evaluation of alternative monetary policy regimes is separate in the areas of exchange rate arrangements and inflation targeting strategy. The absence of a well-defined regime for a floating exchange rates and non-inflation targeters makes the assessment of a specific monetary policy strategy less convincing. One of the explanations for this separation in monetary policy literature rests on the absence of a comprehensive and, more importantly, *de facto* classification for monetary policy regimes.

This paper offers a *de facto* classification for two major and widely used monetary policy strategies: exchange rate targeting and inflation targeting. Countries in the 35-year post-Bretton Woods period are grouped into the two regimes according to their actual behavior in the instrument and target variables using K-means cluster analysis.

The validity of the classification in this study is supported with the consistency between the evidences revealed in this paper and the findings in existing literature. Evolution of two monetary policy regimes in various countries over years provided from the classification results are in accord with the conventional understanding of

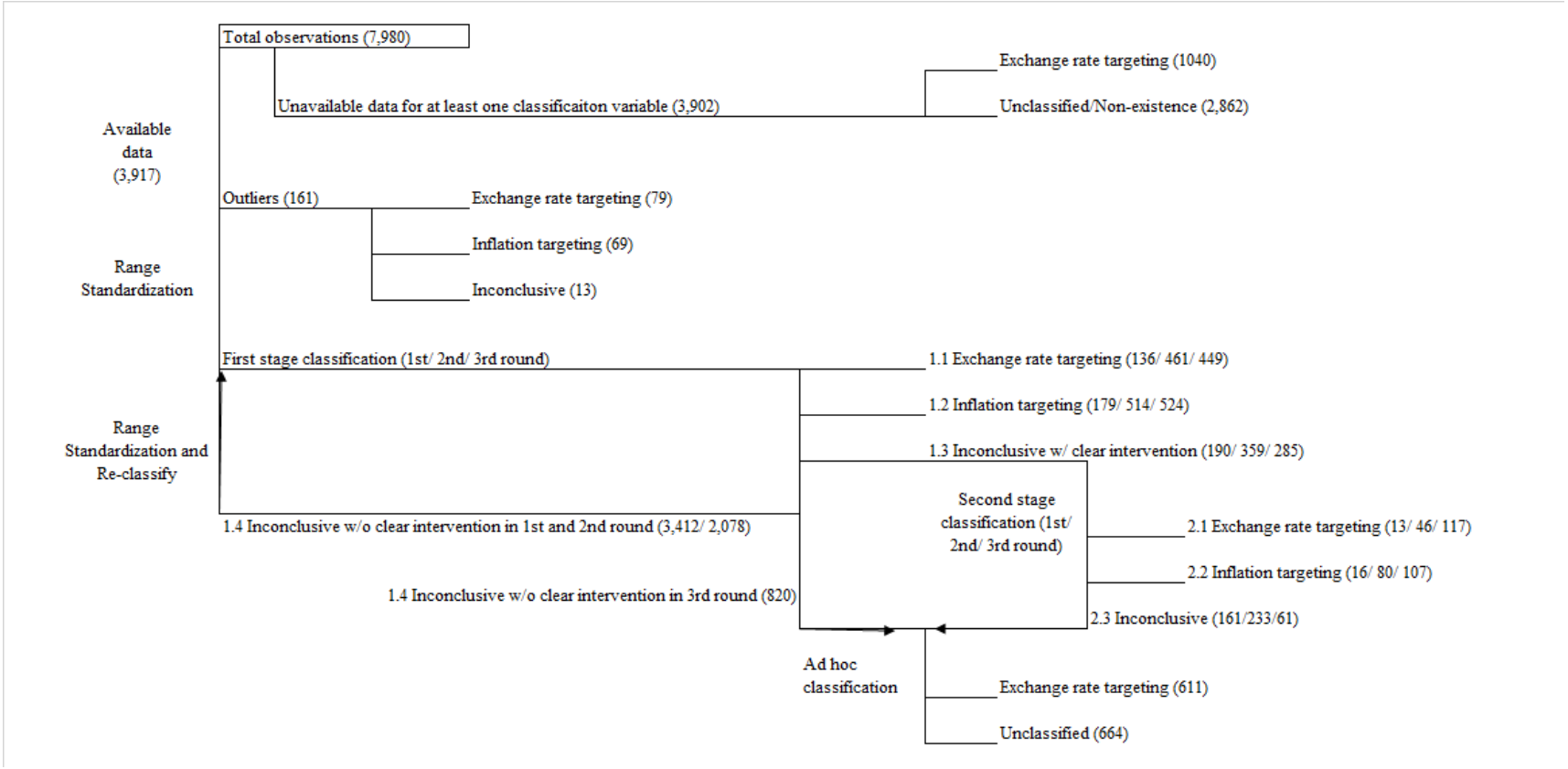
monetary policy history, in general. The economic performance and characteristics of the two regimes as well as the determinants of the choice of monetary policy regimes also agree with other studies in the literature. The inclusion of a well-defined, inflation targeting regime as the alternative in the classification, on the other hand, avoid the misclassification of widely-agreed inflation targeters as exchange rate targeting countries. The *de facto* classification approach based on the observed behavior of economic variables instead of announced inflation targets also helps reveal the existence of "hidden inflation targeters".

Stylized facts of the two monetary policy regimes documented should shed light on the possible effects of monetary policy strategy on economy. However, it is important to note that comparisons on various economic performances of the two regimes are unconditional and therefore require caution in interpretation. Nevertheless, the *de facto* classification of monetary policy regimes in this study should pave the way for future exploration of the economic impacts of alternative monetary policy regimes.

Appendix A: Data Definitions and Sources

Variables	Definitions and sources
Crisis tally	Crisis tally in the database from Reinhart and Rogoff (2011).
Capital openness	The sum of absolute value of inward and outward flows of portfolio investments as a ratio of GDP (source: IFS)
Exchange rate volatility	The standard deviation of absolute monthly percentage changes of nominal exchange rate in a calendar year (source: IFS).
Interest rate volatility	The standard deviation of absolute monthly changes of money market rate in a calendar year, supplemented with lending rate and monetary policy related interest rate (source: IFS).
Inflation	Annual percentage change in consumer price index, supplemented with retail price index (source: IFS).
Inflation volatility	The standard deviation of absolute monthly changes in consumer price index over the current and next year, supplemented with monthly changes in retail price index and quarterly changes in consumer price index with adjustment (source: IFS).
Nominal effective exchange rate volatility	The average of absolute monthly percentage changes of nominal effective exchange rates in a calendar year (source: IFS).
Real effective exchange rate volatility	The average of absolute monthly percentage changes of real effective exchange rates in a calendar year (source: IFS).
Real GDP	Gross domestic product in USD at current prices adjusted with the real GDP growth rate (source: World Bank).
Real GDP growth	Annual percentage change in gross domestic product at constant prices (source: World Bank).
Real GDP per capita	Gross domestic product per capita in USD at current prices adjusted with real GDP growth rate (source: World Bank).
Trade openness	The sum of exports and imports over GDP (source: IFS).
Trade concentration	The maximum share of total trade to a specific country (source: Direction of Trade Statistics, IMF)
Years in office	Years the incumbent administration has been in office (source: database of Political Institutions 2012)

Appendix B: The Classification Procedure



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